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OBSERVATIONS ON SOIL FAUNA ACTIVITY AND ON MIDGUT CONTENT OF COLLEMBOLA

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In a previous paper we made preliminary observations on the decomposition of organic material in a wood of Quercus ilex (Malatesta et al., 1986). Here we complete that analysis with the final results. The study was also extended to the examination of the intestinal content of the main species in the area.

MATERIAL AND METHODS

The area investigated and the methods used for samples are those described previously (Malatesta et al., 1986). In order to analyse gut contents individuals of Orchesella villosa (Geoffroy) were collected alive in their habitat by aspirator at about 3-week intervals between October 1988 and June 1989. Eighty specimens were captured each time, taken as quickly as possible to the laboratory, treated with carbon dioxide, rapidly frozen and stored at -20°C.

The frozen specimens were dissected in a cacodylate buffer solution (0.1M, pH 7.2). The body tissue was removed and the gut, after brief fixation in 2.5 % glutaraldehyde buffered at pH 7.2 with 0.1 M sodium cacodylate, was dissected out to obtain the gut contents.

After this preliminary treatment two groups of twenty guts each were prepared for scanning electron microscope, and two others for light microscope observation. The material for S.E.M. was prepared by the critical point drying method in a Balzer CPD 010, then covered with a film of gold and observed with a Philips SEM 501.

For optical microscope observation, the material was dispersed in a small drop of 10 % cacodylate buffer solution in glycerol and mounted on a microscope slide under a cover slip. A Leitz Aristoplan microscope was used and photographs were taken both in normal lighting and interferce contrast T (I.C.T.) using Ilford Pan F film.

RESULTS AND DISCUSSION

The results obtained for the degradation of organic matter are illustrated in Fig. 1. The yearly sample weight decrease was homogeneous. In both curves there is an increase in weight in the last 2 months of ob-

servation. Two explanations are possible: 1) an increase in fungus hyphae on both sides of the leaf discs; 2) synthesis phenomena due to humification with capture of molecules of atmospheric oxygen (Stachurski and Zimka, 1976; Proth, 1978). It is interesting that there was a homogeneous decrease in weight of samples at the beginning of the experiment; later the loss of weight was highly variable and occasionally a sample was found to weigh three times more than others (Figs. 2,3). Similar variations were observed in the number of specimens in the different samples. This might be justified by the fact that there are different microhabitats in the area. Despite the apparent homogeneity of the vegetation, the soil shows marked heterogeneity.

If we consider the total number of Collembola in the different months of the year (Fig. 4), three periods can be recognized: the first is from March to June, the second from August to October and the third from December to January. In February, July and November Collembola are few in number or absent. The families Isotomidae, Entomobryidae and Hypogastruridae are the most common (Fig. 5).

In order to obtain information on the contribution of Collembola to the decomposition of organic matter in the selected area, we checked the variety of food sources. Of the species in the area we selected Orchesella villosa, a convenient species because of its abundance and size. Since the pioneering work of McNamara (1924) several authors have tried to study the food sources of Collembola (De Bernardi and Parisi, 1968; Mc Millan 1975; Anderson and Healey, 1972; Joosse, 1977; Kilbertus and Vannier, 1979; Hagvar, 1988) but have always encountered technical and

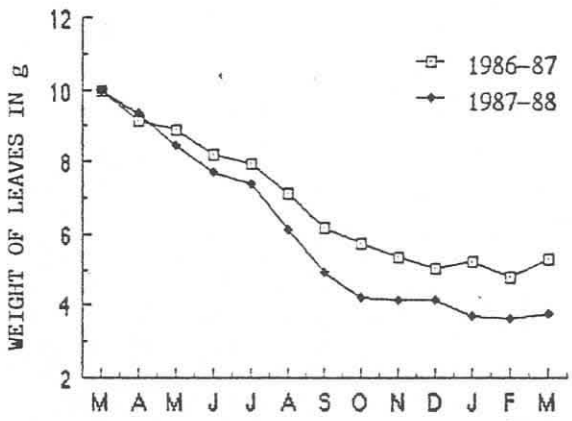

Fig. 1

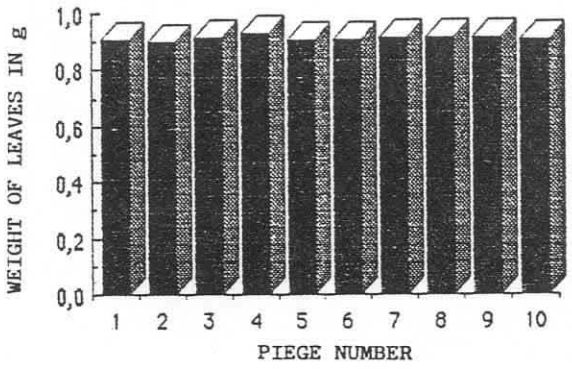

Fig. 2

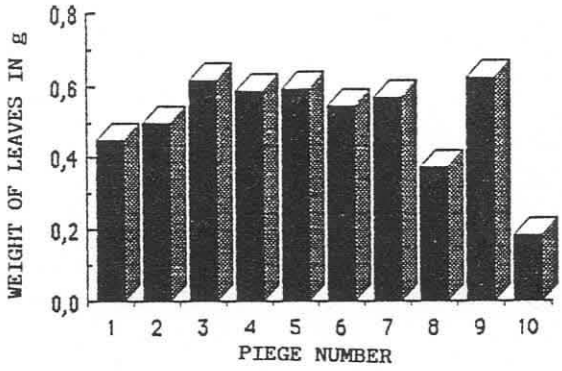

Fig. 3

methodological difficulties.

We counted the number of specimens with an empty gut and found an average of 38%. This is in agreement with data obtained studying other species (Anderson and Healey, 1972, Bodvarsson, 1973; Joosse and Testerink, 1977; Hagvar and Kjondal, 1981). We suggest that these results are related to moulting, although the time between two successive moults varies according to species (Thibaud, 1976). In the samples we examined (Fig. 6), we found a great number of specimens in moult every 60 days. This seems to confirm the existence of a process of synchronization of moulting (With, 1971; Joosse and Testerink, 1977). As for the composition of the intestinal content we divided the material we were able to identify (about 30% could not be identified) into two parts according to its organic and inorganic origin. The inorganic part included several types of crystal: at least 8 different types (Pl. I). In order to eliminate doubts about their origin we analyzed each type of crystal with an EDAX microanalyser mounted on a Philips SEM 515. In this way we were able to identify 5 groups of crystals: 1, Ca; 2, Si; 3, Mg; 4, K-Si-Al; 5, Si-Na-Mg-Al-Ca.

As none of these elements is present in the solution used for the preparation of samples (or if so, only in very small quantities) we suggest that they come from the environment. Similar material was found in the gut of Proturan species by Dallai (1977). A film of bacteria can presumably develop on such crystals and this may constitute an additional source of food. In the gut, in fact, we found colonies of bacteria. Further analysis will verify this idea.

As to the ingested cuticle of Entomobryidae (Pl. II, Fig. 1,3) it is

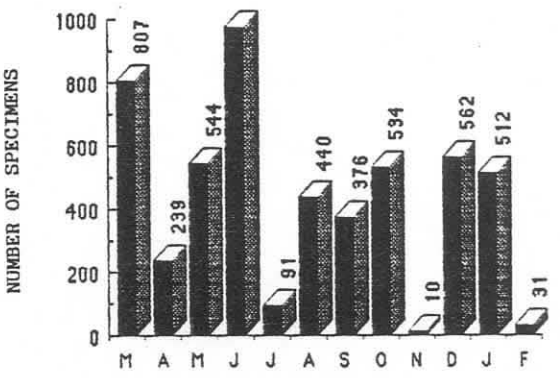

Fig.4

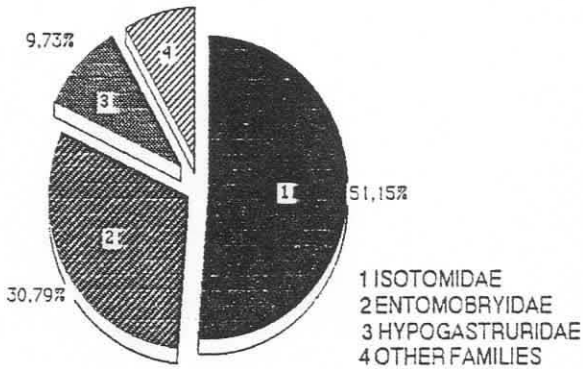

Fig.5

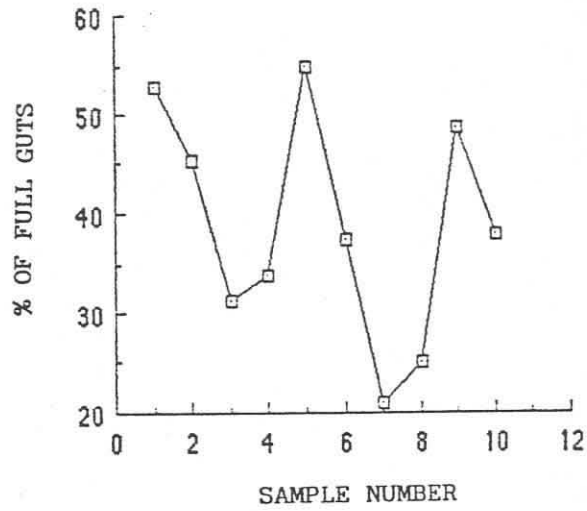

Fig.6

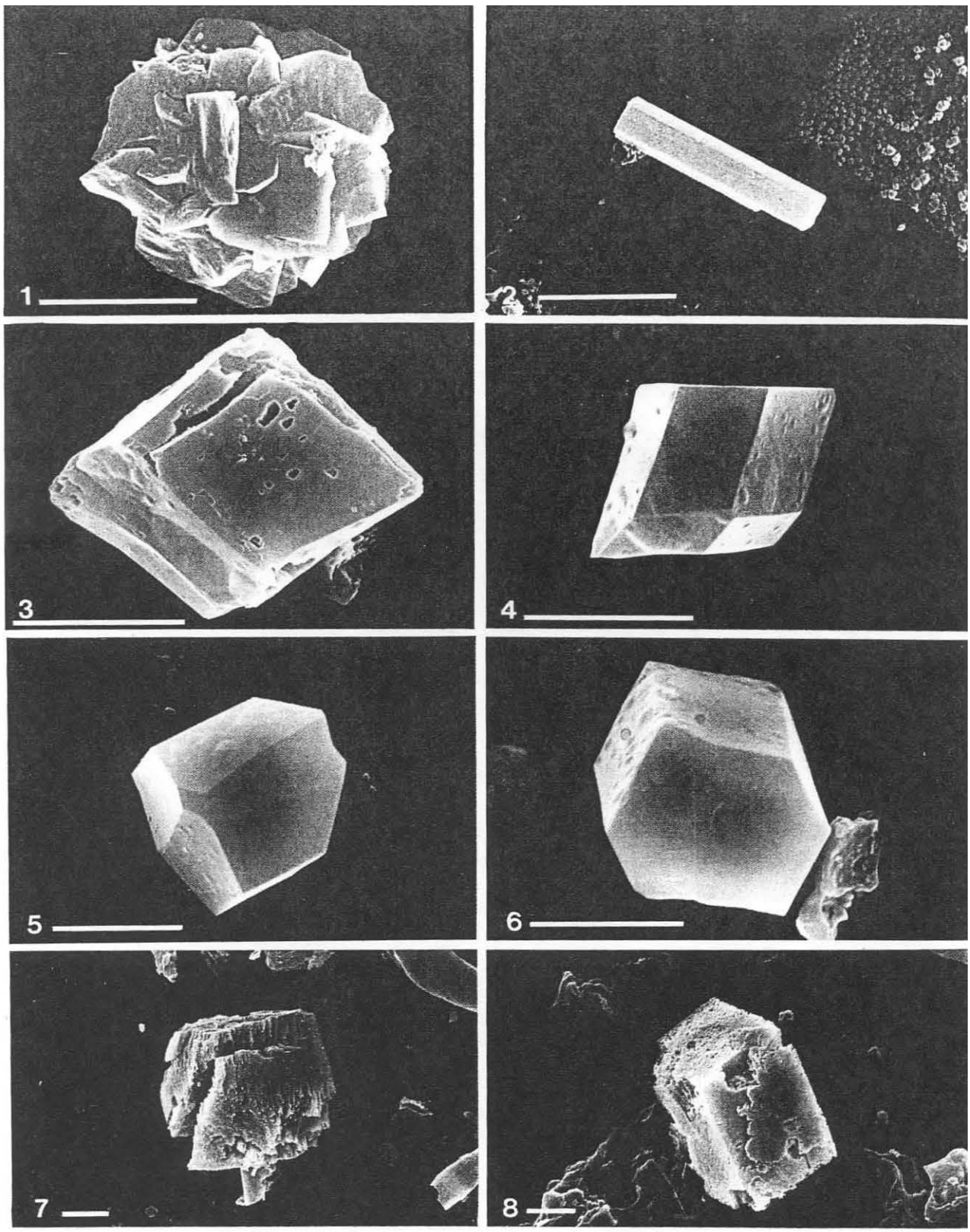

Plate I. Several kinds of cristals. Bar length 10 μm.

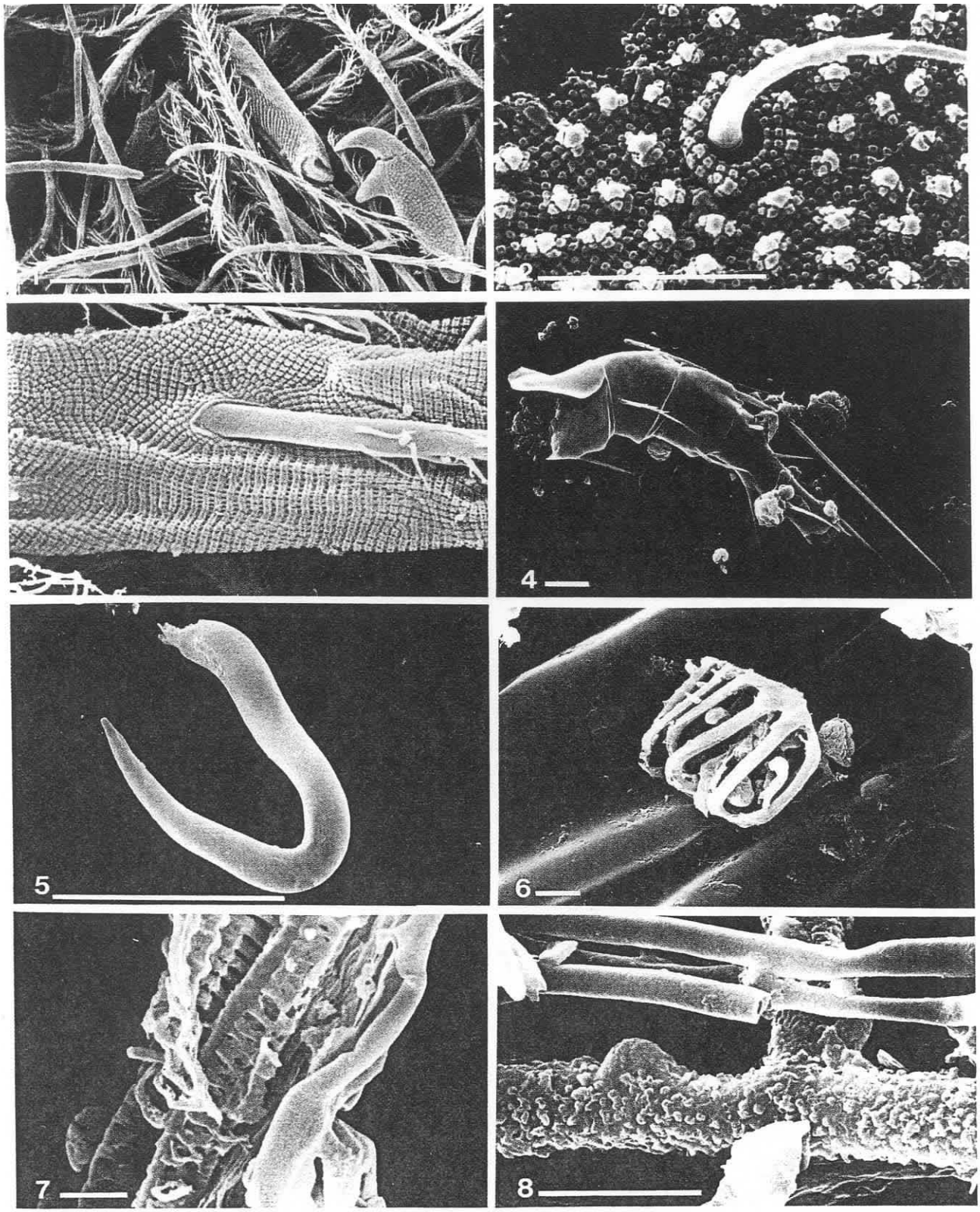

Plate II. 1-2-3) Cuticle fragments of springtails. 4) Cuticle part of mites. 5) Nematod. 6-7) Tracheids. 8)Hyphae of fungi. Bar length 10 μm.

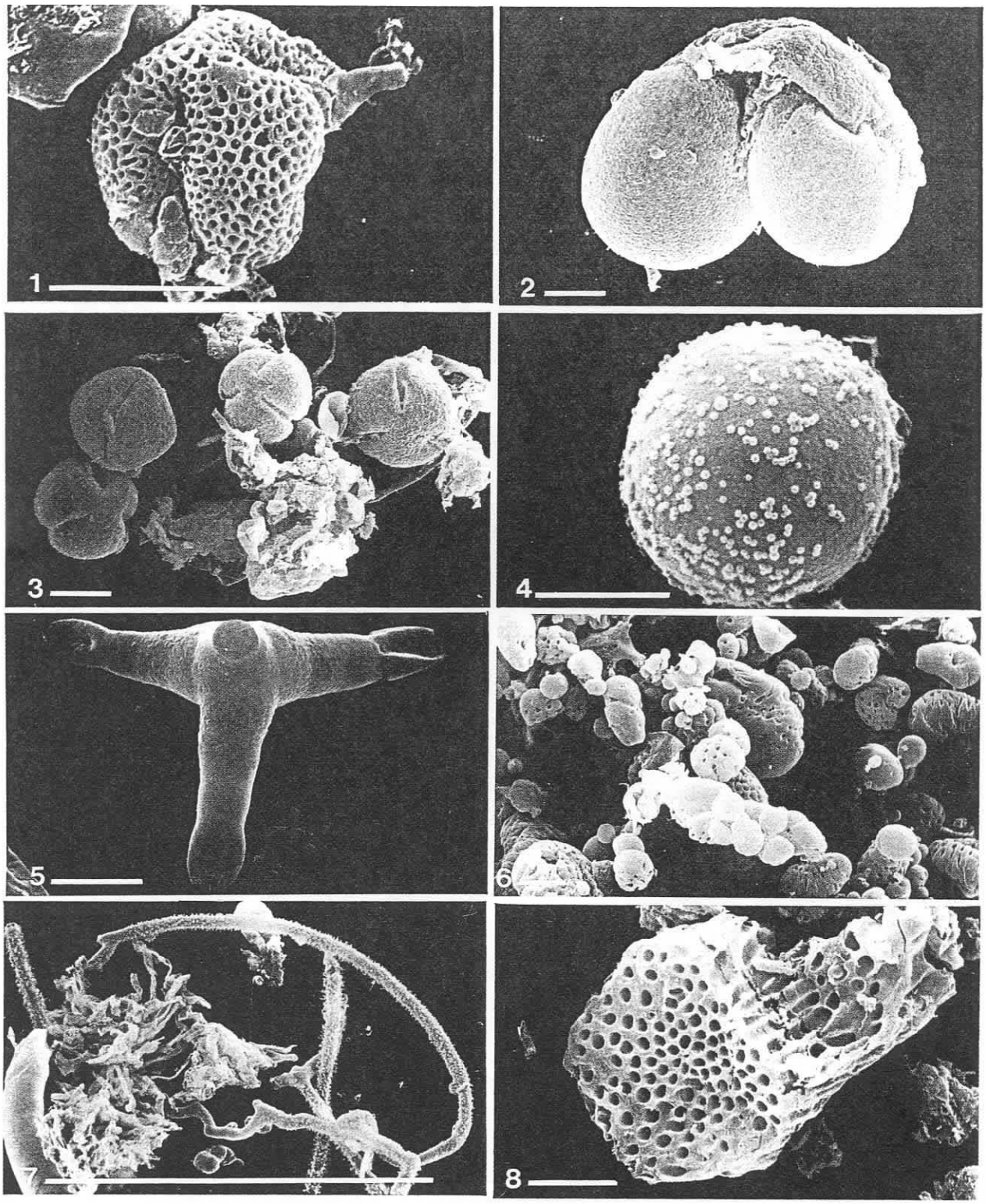

Plate III. Pollen grains: 1) Salicaceae. 2) Pinaceae. 3) Quercus ilex. 4) Cupressaceae. 5) Conidium of Triposporium s.p.: (Hiphomycetes). 6-8) Undetermined leaf material. 7)Hyphae of undetermined fungi mixed with leaf material. Bar length 10 µm.

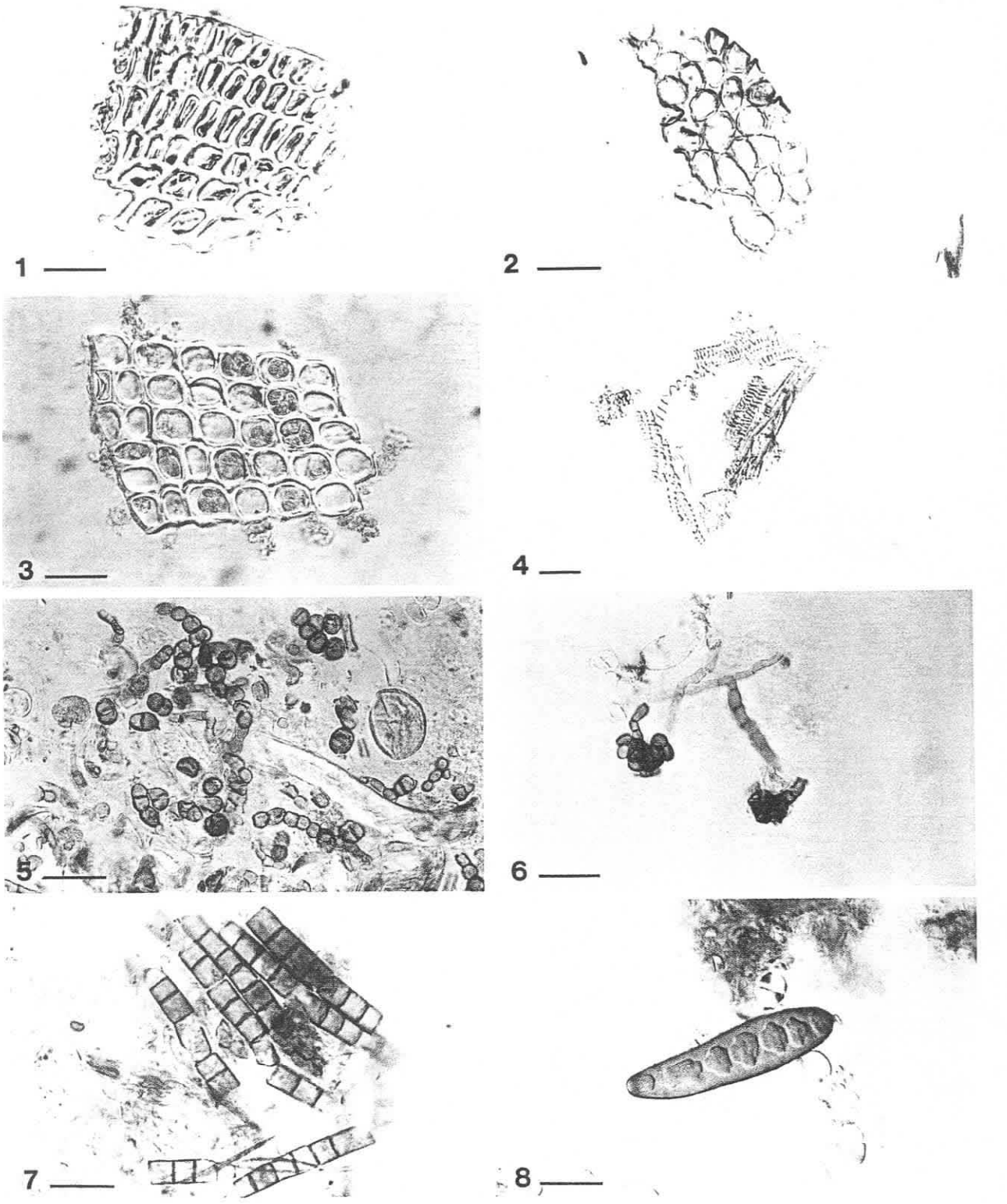

Plate IV. 1-2-3) Elements of xylem. 4) Tracheids. 5-6-7-8) Conidia of several fungi. Bar length 20 μm.

likely that even Orchesella villosa can eat its own exuvia after a molt, as occurs in other Collembola (De Bernardi and Parisi, 1968). As to the cuticle of different origin (Pl. II, Figs. 2,4), we can only suppose that a predation occurs as well as simple coprophagy. We also found Nematods (Pl. II, Fig. 5). Eggs or larvae may have been ingested and grown in the gut.

Finally, the most abundant vegetal material were fungi (Pl. II, Fig. 8; Pl. III, Fig. 7; Pl. IV, Figs. 5,6,7,8). Most were Hyphomycetes of subclass Dematiaceae, and in particular we were able to recognize Conidiophora and Conidia, such as the one in Plate III, Fig. 5, which belongs to the genus Triposporium. These fungi live on fallen leaves and it is not surprising to find them in the gut. Fragments of such leaves (Pl. IV, Figs. 1,2,3) are present together with tracheids (Pl. III, Fig. 6), portions of xylema (Pl. III, Fig. 7; Pl. IV, Fig. 4) and different pollen grains such as those of Salicaceae, Pinaceae, Q. ilex and Cupressaceae (Pl. II, Figs. 1,2,3,4).

Some questions are still unsolved: for example, the uptake of crystals from the soil, the ingestion of exuviae and their meaning . We think, however, that the method used in this study and the results so far obtained are promising and of interest to researchers investigating the role of Collembola in the environment.

In conclusion, we confirm the extreme variability of the material ingested by Collembola and also suggest that the group participates more actively even in the transformation of organic matter and the environment.

Acknowledgements

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